TECHNIQUE FOR MONITORING SONET SIGNAL

FIELD OF THE INVENTION

This invention relates to a technique for performance monitoring of the standard SONET (synchronous optical network) signal by examining the quality

5   of its framing signal.

BACKGROUND OF THE INVENTION

The SONET standard defines a field set of criteria encompassing data rates and formats, network segments, network elements and the other factors important for ensuring end-to-end performance of an optical communication

10 network. The current SONET system relies on individual bits in the SONET frame headers to extract performance monitoring indicators such as loss of frame (LOF). Such extraction is relatively easy in systems in which the regeneration of the optical signal is periodically converted to an electrical signal for amplification and then regenerated as an optical signal. However in all-optical

15 regeneration systems, individual bits are no longer available at section or line network elements, such as all-optical regenerators or all-optical cross-connects. This absence of individual bits complicates the problem of performance monitoring of all-optical systems. The present invention seeks an improved technique for performance monitoring of optical communication systems. Such

20 monitoring is important to insure healthy network operation.

SUMMARY OF THE INVENTION

The present invention provides an improved technique for performance

monitoring of an optical communication system that complies with a SONET-type

standard. More particularly, the present invention involves the spectral analysis

of the SONET signal to eliminate therefrom the framing signal that serves to

identify the start of each frame of the signal and to use the energy remaining in

its time slot as performance-measuring indicators of the signal. The use of

spectral analysis of the SONET traffic obviates the need for accessing individual

bits of the signal, which greatly simplifies the process of performance monitoring.

The present invention is based on the recognition that the SONET fram-

ing sequence has a spectral structure different from that of the rest of the signal,

which is generally much more random. In particular, modulation domain analysis

can successfully recognize this difference and show the transition between the

framing signal and the rest of the signal as a function of time. In this way, the

SONET framing pulses are extracted directly from the SONET traffic without

accessing actual individual data bits.

In particular, when there is removed the framing signal, there remains in

its time slot the noise that has accumulated in such time slot. The framing signal

for OC-N traffic is a periodic sequence of N bytes of A1 and N bytes of A2. This

noise will be a measure of the quality of the framing signal and should indicate

any loss of frame. This noise will generally be of a lower power level than the

remainder of the signal that includes the data pulses so that the time slot of the

detected framing signal noise can be readily recognized by inspection for use in

monitoring of the quality of the framing signal. To facilitate such inspection the

signal now available can first be passed through a square law detector.

The invention will be better understood from the following more detailed

5 description taken in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 shows a block schematic of apparatus for recovery from the optical

carrier signal of a SONET system for extracting the framing signal in accordance

with the invention.

10 FIG. 2 shows in schematic form the basic elements of an exemplary em-

bodiment of the apparatus of FIG. 1.

DETAILED DESCRIPTION

In the system 10 shown in FIG. 1, the optical carrier (OC) received is first

supplied to a standard optoelectronic apparatus 12, such as a PIN diode, that

15 converts the optical signal to an electrical signal. This signal is then supplied to

a notch filter 14 designed to filter out the repetitive framing signal while passing

the noise associated with it remaining in its time slot at lower power as well as

the higher random data signal power.

The output of the filter 14 is now supplied to a square law detector 16

20 which further discriminates between the low power framing signal noise and the

high power data signal so that, in a visual display of the result, there is readily

recognized the framing signal noise and its level determined. Remedial action

can then be taken when the framing signal noise is detected to be above some specified level.

In FIG. 2 there is shown in greater detail within the broken line 100 an exemplary embodiment 20 of the electronic circuitry for treating the optical SONET signal after it has been converted to its electronic form.

In particular, the exemplary circuitry 20 includes a 50 ohm termination 21, which is supplied with the converted electrical input and which is included to minimize the effect of any reflections in the circuitry. This is followed by a low-pass notch filter 22 comprising, for example, two 50 ohm lengths of transmission 22A, 22B line and two one-quarter wavelength stubs 22C, 22D, of which 22C is open-ended and 22D shorted, to form a notch filter that passes the framing signal noise and the data payload, but blocks the framing signal. To this end, the filter is designed to generate notches at $\frac{n}{8}\left(\frac{1}{T_D}\right)$ where n is 1...8, and T_D is the data rate of the OC traffic. The filter output is then supplied to a diode 24 that serves as a squaring circuit for providing a low voltage-signal for low signal-power but supplying a relatively higher voltage for higher powers to provide increased discrimination between low and high powers. This facilitates distinguishing the relatively high data-power from the relatively low framing-signal noise power. Now there is included a video low-pass filter 26 that passes selectively the video framing signal noise voltage, which, after amplification in amplifier 28, can be viewed for use in monitoring the operation.

It should be understood that the embodiment described is merely illustrative of the general principles involved; other embodiments should be feasible without departing from the spirit and scope of the invention.